1261 Issued June 21, 1910.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 405.

Experiment Station Work, LVII.

Compiled from the Publications of the Agricultural Experiment Stations.

A PERFECT STAND OF CORN.
PROTECTION OF SEED CORN.
CLOVER-SEED PRODUCTION.
HOME-GROWN FEEDS FOR HOGS.
FLESHING HORSES FOR MARKET.
FERTILITY AND HATCHING OF EGGS.
MARKETING OF EGGS.
CEMENT SILOS.

MARCH, 1910.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

THE AGRICULTURAL EXPERIMENT STATIONS.

ALABAMA—
College Station: *Auburn;* J. F. Duggar.[a]
Canebrake Station: *Uniontown;* F. D. Stevens.[a]
Tuskegee Station: *Tuskegee Institute;* G. W. Carver.[a]

ALASKA—*Sitka:* C. C. Georgeson.[b]

ARIZONA—*Tucson:* R. H. Forbes.[a]

ARKANSAS—*Fayetteville:* C. F. Adams.[a]

CALIFORNIA—*Berkeley:* E. J. Wickson.[a]

COLORADO—*Fort Collins:* L. G. Carpenter.[a]

CONNECTICUT—
State Station: *New Haven;* E. H. Jenkins.[a]
Storrs Station: *Storrs;* L. A. Clinton.[a]

DELAWARE—*Newark:* Harry Hayward.[a]

FLORIDA—*Gainesville:* P. H. Rolfs.[a]

GEORGIA—*Experiment:* Martin V. Calvin.[a]

GUAM—*Island of Guam:* J. B. Thompson.[b]

HAWAII—
Federal Station: *Honolulu;* E. V. Wilcox.[b]
Sugar Planters' Station: *Honolulu;* C. F. Eckart.[a]

IDAHO—*Moscow:* W. L. Carlyle.[a]

ILLINOIS—*Urbana:* E. Davenport.[a]

INDIANA—*Lafayette:* A. Goss.[a]

IOWA—*Ames:* C. F. Curtiss.[a]

KANSAS—*Manhattan:* E. H. Webster.[a]

KENTUCKY—*Lexington:* M. A. Scovell.[a]

LOUISIANA—
State Station: *Baton Rouge.*
Sugar Station: *Audubon Park, New Orleans.*
North Louisiana Station: *Calhoun.*
Rice Experiment Station: *Crowley;* W. R. Dodson (*Baton Rouge*).[a]

MAINE—*Orono:* C. D. Woods.[a]

MARYLAND—*College Park:* H. J. Patterson.[a]

MASSACHUSETTS—*Amherst:* W. P. Brooks.[a]

MICHIGAN—*East Lansing:* R. S. Shaw.[a]

MINNESOTA—*University Farm, St. Paul:* A. F. Woods.[a]

MISSISSIPPI—*Agricultural College:* J. W. Fox.[a]

MISSOURI—
College Station: *Columbia;* F. B. Mumford.[a]
Fruit Station: *Mountain Grove;* P. Evans.[a]

MONTANA—*Bozeman:* F. B. Linfield.[a]

NEBRASKA—*Lincoln:* E. A. Burnett.[a]

NEVADA—*Reno:* J. E. Stubbs.[a]

NEW HAMPSHIRE—*Durham:* W. D. Gibbs.[c]

NEW JERSEY—*New Brunswick:* E. B. Voorhees.[a]

NEW MEXICO—*Agricultural College:* L. Foster.[a]

NEW YORK—
State Station: *Geneva;* W. H. Jordan.[a]
Cornell Station: *Ithaca;* H. J. Webber.[c]

NORTH CAROLINA—
College Station: *West Raleigh;* C. B. Williams.[a]
State Station: *Raleigh;* B. W. Kilgore.[a]

NORTH DAKOTA—*Agricultural College:* J. H. Worst.[a]

OHIO—*Wooster:* C. E. Thorne.[a]

OKLAHOMA—*Stillwater:* J. A. Craig.[a]

OREGON—*Corvallis:* J. Withycombe.[a]

PENNSYLVANIA—
State College: T. F. Hunt.[a]
State College: Institute of Animal Nutrition; H. P. Armsby.[a]

PORTO RICO—*Mayaguez:* D. W. May.[b]

RHODE ISLAND—*Kingston:* H. J. Wheeler.[a]

SOUTH CAROLINA—*Clemson College:* J. N. Harper.[a]

SOUTH DAKOTA—*Brookings:* J. W. Wilson.[a]

TENNESSEE—*Knoxville:* H. A. Morgan.[a]

TEXAS—*College Station:* H. H. Harrington.[a]

UTAH—*Logan:* E. D. Ball.[a]

VERMONT—*Burlington:* J. L. Hills.[a]

VIRGINIA—
Blacksburg: S. W. Fletcher.[a]
Norfolk: Truck Station, T. C. Johnson.[a]

WASHINGTON—*Pullman:* R. W. Thatcher.[a]

WEST VIRGINIA—*Morgantown:* J. H. Stewart.[a]

WISCONSIN—*Madison:* H. L. Russell.[a]

WYOMING—*Laramie:* J. D. Towar.[a]

[a] Director. [b] Special agent in charge. [c] Acting director.

EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

CONTENTS OF NO. LVII.

ILLUSTRATIONS.

EXPERIMENT STATION WORK.[a]

A PERFECT STAND OF CORN.[b]

A perfect stand of corn is that which produces the greatest possible yield. This is affected by the number of stalks and their arrangement on the surface of the soil. Of course, a perfect stand for one soil might be only half a stand for another, while a perfect stand for a wet season might be too thick a stand for the same soil in a dry season. However, no absolute rules can be laid down which will enable the corn grower to decide how far apart he shall make his rows or how thick the stalks or hills shall stand in the row. No one can foretell what the season will be. The number of square feet of soil required to support a hill or stalk of corn varies with the soil fertility, cultivation, rainfall, and other seasonal or climatic conditions, the variety of corn, and many other factors. While it is probably impossible to secure a perfectly even distribution of stalks or hills, recent experiments and experience combine to indicate that each stalk or hill should stand as nearly as possible in the center of a square of soil from which it draws its food. The size of this square will, of course, be determined by the distance between stalks in the row and between rows. What this distance should be under the conditions existing in the different corn-growing States may be suggested, if not finally determined, by the tests carried on in the different States.

At the Nebraska Station corn grown in hills 44 inches apart, each way, produced the highest yield of grain when planted at the rate of 4 kernels per hill, but 5 kernels produced an almost equally high yield of corn and a slightly greater yield of stover. Two kernels per hill produced the largest ears and 1 kernel per hill the greatest number of 2-eared plants, tillers, and ears per hundred plants. The percentage of barren plants increased with the number of plants per hill. These facts sometimes lead seed growers to plant very thinly in the hope of producing very large ears for seed, but the opposite practice is found to result in seed having the greatest producing power, as it may result in the elimination of barren plants and those that do not produce well under adverse conditions. Corn grown

[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Alabama Sta. Bul. 88; Georgia Sta. Bul. 46; Indiana Sta. Bul. 55; Kansas Sta. Bul. 45; Louisiana Stas. Bul. 17 (2. ser.); Maryland Sta. Bul. 25; Maine Sta. Rpt. 1895; Missouri Agr. Col. Bul. 32; Nebraska Sta. Buls. 91, 112; Ohio Sta. Bul. 78; Texas Sta. Bul. 49. See also U. S. Dept. Agr., Farmers' Bul. 360, p. 5.

at three rates, namely, at 1, 3, and 5 plants per hill, for three years showed an average producing power of 3.6 bushels more for the thickest planting than for the thinnest.

At the Kansas Station corn was grown in rows, 2, 2½, 3, 3½, and 4 feet apart, and from 4 to 20 inches apart in the row; both listed and surface-planted corn were tested in rows 3½ and 4 feet apart, but all narrower rows were surface planted. In 1893 both listed and surface-planted corn gave the best results when the rows were 4 feet apart and the stalks 16 inches apart, while in 1891 the best results were obtained when rows were 3½ feet apart, stalks 16 inches apart.

The average results for three years' work at the Missouri Station indicate that the maximum yields from corn planted in hills 45 inches apart each way was obtained from planting 3 or 4 grains per hill, 4.3 bushels per acre less being secured from planting 2 grains per hill. Lower yields were secured in hills 45 by 22½ or 45 by 15. On good land the largest yield of 70.4 bushels per acre was secured by leaving 4 stalks per hill in hills 45 inches apart each way, while on poor land the largest yield of 36 bushels per acre resulted from thinning to 2 stalks per hill. Four stalks per hill gave a yield of 6.6 bushels less per acre, more than half of which was unmerchantable. One stalk per hill produced almost as large yield on poor land as did 4, and almost every ear was merchantable. In all cases the thicker the planting the larger the yield of stover and the greater the proportion of nubbins. Eighty-five per cent of a stand produced 2½ bushels per acre more grain than did 85 per cent of a stand in which the missing hills were replanted and 12 bushels more than when the entire plat was planted over. Ninety-four per cent of a perfect stand produced 2.2 bushels per acre more than 85 per cent of a perfect stand.

At the Ohio Station 1 grain every 12 inches or 2 gains every 24 inches produced better results than 3 grains every 36 inches or 4 grains every 48 inches. One grain every 18 inches proved insufficient to secure a maximum crop, but produced the largest percentage of ears. Four grains every 42 inches proved entirely too thick for best results. The work was continued for three years.

Ten years' test at the Indiana Station showed that in seasonable years the yields of both corn and stover are greater from thick planting, but that in the very dry year of 1894 the yield of corn was less and of stover greater from thick planting.

At the Maine Station 1 acre of land fertilized with 10 2-horse loads of stable manure and 750 pounds of commercial fertilizer produced, respectively, 5,246, 5,390, and 4,848 pounds per acre of dry matter when kernels were planted 6, 9, and 12 inches apart, but the ears were larger when the planting was at a distance of 9 and 12 inches.

At the Louisiana Station stalks 18 inches apart in 5-foot rows produced the largest results, although a closer planting might have

proved more profitable during a more favorable season, but is not recommended as a general practice.

At the Alabama Station, on poor and sandy land to which complete fertilizer was added at the rate of 320 pounds per acre, the yield was largest when the constant area devoted to each plant produced was a perfect square in shape; that is, when 15 square feet was so planted that the distance in the drill was about equal to the distance between rows. The highest average yield for two years resulted from single plants 3 feet 9 inches apart in rows 4 feet apart, but plants 3 feet apart in rows 5 feet wide were more cheaply cultivated. A row of cowpeas should be planted between corn rows on very poor land, in which case the corn rows should be at least 5 feet apart.

At the Georgia Station ten years' experiments indicated that land capable of producing 25 to 40 bushels of shelled corn per acre should be so planted as to grow 3,630 plants per acre. This number may be secured by planting 32 inches apart in 4½-foot rows, 36 inches apart in 4-foot rows, or 42 inches apart in 3½-foot rows. Soil capable of producing 15 to 25 bushels per acre produces its maximum yield when 16 square feet are allowed per plant, or 2,722 plants per acre. This number would be secured by planting 38½ inches apart in 5-foot rows, 32 inches apart in 4½-foot rows, or 48 inches apart in 4-foot rows. Soils capable of producing 10 to 15 bushels per acre give their maximum yield when 18 to 24 square feet per stalk is allowed, or from 2,420 to 1,850 hills to the acre. Eighteen square feet per stalk may be secured by planting 36 inches apart in 6-foot rows, or 43 inches apart in 5-foot rows, or 4 feet 3 inches apart each way.

At the Maryland Station the narrower rows and thinner seedings gave the larger returns in a comparison of plantings at intervals of 15 inches in rows 3 feet 8 inches apart and at intervals of 12 inches in rows 5 feet apart.

At the Texas Station the highest average yield for 5 varieties tested resulted from planting 4 feet by 2½ feet apart, while the planting 3 feet by 2½ feet apart stood second, 5 by 3 third, and 4½ by 3 gave the lowest yields. Golden Beauty and Leaming produced the best yields from close planting, while Thomas, 100-day Bristol, and Forsyth Favorite did best in 4-foot rows planted 2½ feet apart in the drill.

The increase of 2.2 bushels per acre which the work at the Missouri Station indicated would result from improving the stand from 85 to 94 per cent of a perfect stand would, if secured for each of the 108,771,000 acres devoted to corn crop in 1909, secure an increase of $142,620,535.20 at the farm value of 59.6 cents per bushel.[a] As a matter of fact, however, comparatively few fields have even 85 per cent of a perfect stand. In view of the opinion of prominent authorities on this subject, that the average cornfield has not over 66 per

[a] U. S. Dept. Agr., Bur. Statis. Crop Reporter, 11 (1909), No. 12, Sup.

cent of a perfect stand, while in many cases the percentage is less than 40, it is difficult to compute the loss resulting to the corn growers of the United States from this cause.

PROTECTION OF SEED CORN FROM BURROWING ANIMALS.[a]

T. H. Scheffer, of the Kansas Station, has tested various treatments of seed corn to protect it from burrowing animals. He finds that—

Kerosene, crude petroleum, copperas, crude carbolic acid, fish oil, and spirits of camphor, when used in sufficient quantity or strength to impart an odor to the corn, seriously injure the germinating powers of the grain. To treat the seed with any of these substances in such small quantity or dilute form as not to injure the germ is a waste of time, for the slight taste or odor imparted is soon dissipated in contact with the soil.

"Mixing pulverized gum camphor with the dry grain and storing it in a closed vessel for some days has been recommended as an efficient treatment," but it imparted little or no odor to the grain and gave only negative results in the Kansas experiments. Pine tar gave a strong odor but made the grain too sticky to work in a planter.

Of the substances which gave promising results—

Coal tar makes an ideal coating of a rich brown color and a persistent gassy smell. It dries nicely, is not in the least sticky, and will work well in a planter. Wet the grain with a little warm water before stirring in the tar. A teaspoonful of the latter will be sufficient for a peck of corn. The mass must be thoroughly mixed and then dried before attempting to plant. Soaking corn in strong tobacco decoction for a few hours, or simply wetting it with the liquid, seems to promise good results. Of course, the grain must be thoroughly dried before planting. It will have a strong odor and will not be sticky.

The observations of the Kansas Station indicate that field mice are the chief offenders in the matter of destroying seed corn and that moles rarely or never do any damage of this kind. The Bureau of Biological Survey of this Department recommends preventative rather than corrective measures in dealing with field mice. Among the measures recommended for this purpose by the Survey are the following:

(1) Protection of the natural enemies of field mice, particularly owls, most hawks, shrikes, snakes, skunks, badgers, and most species of weasels.

(2) Elimination of the breeding grounds of field mice by draining swamps and cleaning waste places that afford the animals harborage.

(3) Periodic plowing of grass and other lands for the rotation of crops.

(4) Clean cultivation of corn and all other crops, and especially of orchards and nurseries.

(5) Clean mowing of grass lands and permanent meadows, so that no old grass is left over winter.

(6) Careful burning about orchards and gardens of weeds, trash, and litter of all kinds that may serve the animals for winter shelter.

(7) When necessary, the burning of dead grass in meadows and pastures. This, however, should not be delayed till late spring, when ground birds are nesting.

---

[a] Compiled from Kansas Sta. Circ. 1; U. S. Dept. Agr., Biol. Survey Bul. 31.

Alfalfa or crushed wheat poisoned with strychnin have also been successfully used by the Survey in destroying the mice. The details of the method employed are given in the Yearbook of the Department for 1908, page 431.

CLOVER-SEED PRODUCTION IN THE NORTHWEST.[a]

In a bulletin of the Wisconsin Station, by R. A. Moore and E. J. Delwiche, it is stated that no crop surpasses clover seed as a source of ready money in northern Wisconsin. The demand for it is steadily increasing and the price is good. Instead of depleting the fertility of the soil, clover adds nitrogen from the air and loosens the soil to considerable depth by the roots which it sends down and which leave openings through the soil by their decay after the death of the plant. The comparatively large value in a small bulk of clover seed makes it an especially advantageous crop on farms at a considerable distance from market. Several hundred dollars' worth of clover seed may easily be delivered in a single load. So essential is it in Wisconsin and other localities to which it is adapted that "no intelligent person will attempt to farm without it in the crop rotation."

Medium red, mammoth red, alsike, and white clovers are the varieties most commonly grown. The two last named are perennial. The first named are ordinarily biennial, but the winter covering of snow, abundant moisture, and other favorable circumstances tend to make them more perennial in practice, and crops have been cut for several years without reseeding. Red clover is most commonly grown, but alsike is frequently resorted to when the land is too wet for red clover, which is usually grown on loam, hilly or rolling clay soil, and on the dark wet land of the brown to black loam type found in the Willamette Valley. Alsike occupies the "white land" and "mixed land" of this valley, as well as the overflow land along some of the water courses.

Red clover yields from 4 to 6 bushels of seed per acre in the Willamette Valley, but may reach 9 bushels on the better soils, during a favorable season. Alsike will usually make a little higher yield. On the poorest soil, the "white land," on which red clover is rarely produced, alsike yields from 2 to 2½ bushels of seed per acre; on "mixed land" from 3 to 5 bushels, while the best dark, waxy overflow land yields from 6 to 16 bushels per acre. The average yield of red clover seed secured on thirteen farms, cooperating with the Wisconsin Experiment Station was 2¾ bushels per acre. The average yield of alsike on clay soil was 3.96, and on sandy soil 1.78 bushels per acre, while medium red clover yielded 1 bushel per acre on clay soil, 1⅓ bushels on sandy soil, and mammoth red clover yielded in the one case reported 1 bushel per acre on sandy soil.

[a] Compiled from Wisconsin Sta. Bul. 183; U. S. Dept. Agr., Bur. of Plant Indus. Circ. 28.

42303—Bull. 405—10——2

Good seed on a fertile, well-prepared soil is the first essential to clover-seed production. No seed should be sown which contains the seeds of obnoxious weeds. Reliable seedsmen are willing to furnish samples and the state experiment stations will usually test such samples. In some States the buyer has a legal right to demand that the seed presented for sale bear tags, stating its purity and germination tests. If not so labeled, however, he can easily make a germination test for himself. This is a very necessary precaution, because it is impossible to determine by the eye whether or not clover seed will grow. Many failures to obtain a good stand are traceable to sowing of seed, which looked good but showed a germination test of 80 per cent or less.

A simple seed tester may be made with a tin plate and two circular pads fitted in it. The pads may be made of cotton flannel and should be soaked in water, squeezed to remove any undue amount of moisture and kept moist throughout the test by sprinkling from time to time. One hundred seeds from the sample to be tested should be counted out, placed between the pads, and kept at ordinary room temperature. The seeds of high vitality will show vigorous sprouts at the end of four days and may be removed, while the unsprouted seeds are left for two days longer. The total number of seeds that have sprouted by that time will give the germination test of the sample in percentage. A sample testing under 80 per cent should be regarded with suspicion and rejected if better seed is available, or bought at a lower price and sown at a higher rate per acre if it must be used. Seed that is stuck together by honeydew, a sticky substance secreted by aphids or plant lice, passes over the riddles of the fanning mill or other cleaner with the coarse trash. It may be recovered by putting the trash and seed into water, where the honeydew very quickly dissolves. Seed and trash may then be dried and separated as usual in a fanning mill.

Other insect pests affecting clover-seed production are the clover-root borer, which can travel from field to field only during early summer, and may be held in check by fallowing for a short period, and the clover-seed chalcis, which may inhabit the head of the clover and eat out the inner portion of the seed, and may be held in check by burning the clover heads affected. A third species, the clover-flower midge, lays eggs which produce a larva or maggot in the blossom of the red clover, thus preventing seed production. Where clover is grown alone, as it would be for seed, the first crop may be cut sufficiently early to hasten the second blossoming to such extent that it has advanced beyond danger from maggots before the second or fall brood of midges appears.[a]

[a] For further information on insects affecting clover, see U. S. Dept. Agr., Bur. Ent. Bul. 85, Pt. III; Circs. 67 and 69. See also Michigan Sta. Bul. 259.

If the soil has been exhausted by continuous cropping with small grains, it is well to restore it by seeding to vetch for two seasons preceding sowing to clover. The methods of seeding to clover vary almost as widely as do soil and climatic conditions. In the Willamette Valley, the principal methods of securing a stand are by sewing alone or with rape during May or June; by sowing alone in the stubble in the early fall; by sowing in February, March, or April with spring grain or in winter wheat; and by sowing after summer fallow.

On "white land" the sowing of red clover, if attempted, should be preceded by tile drainage and liberal application of barnyard manure. If sown with rape, this crop may be killed by pasturing with sheep or swine during the late fall or in the early spring. Seeding is usually at the rate of from 1 to 3 pounds of rape and 5 pounds of alsike, or 8 to 10 pounds of red clover per acre. The soil should be plowed in the spring and kept well cultivated until seeding time to conserve the moisture and destroy all weeds. Fall plowing can not be substituted for spring plowing on many soils, as the soil particles run together during the winter and a hard seed bed would be presented in the spring.

The practice of sowing clover alone on stubble land is becoming popular. Late spring plowing leaves the land in better condition for such sowing than earlier spring plowing, packed by the spring rains. The seed may be harrowed in or left unprotected, save by the stubble, which is usually left fairly long for protection against the sun and aids in the prevention of heaving in winter. Rich land which has successfully grown clover may be seeded with good results in the early spring with oats or wheat as a nurse crop, if the seed bed is properly prepared. An application of land plaster in early spring is recommended for clover sown in the stubble. Thirty to 40 pounds per acre acts as a powerful stimulant if applied at seeding time or after the young clover has leafed out. Fifty to 100 pounds per acre is applied for the production of a hay crop and is advised by some for a seed crop, although usually regarded as likely to produce too much straw. It may be applied by the methods outlined in Circular 22 of the Bureau of Plant Industry of the United States Department of Agriculture.

When clover is sown in February or March in winter wheat, the grain is frequently cut as high as possible to leave abundant stubble for the winter protection of the clover as well as against the hot rays of the sun during its first summer. An imperfect stand of clover may be remedied by a fall sowing in the stubble.

Summer fallowing is resorted to for the eradication of sorrel, French pink or other weeds, or in case the fertility of the soil has been depleted by continuous cropping with wheat and oats. Moisture is

accumulated, the soil is put into a good mellow condition and bacterial action stimulated to render plant food available for the clover. Eight to 10 pounds of red clover or 5 pounds of alsike per acre are sown after the drilling of wheat or oats, or the clover may be sown with a bushel of vetch per acre. Should the seed start poorly, more may be sown during February or March.

On sandy soils about 15 pounds of clover per acre should be sown and covered over 1 or 2 inches to avoid danger from drought and drifting sand. Should the season be dry, oats used as a nurse crop should be cut for hay before ripening. Barley does not require as much water for its maturity as oats and is therefore preferable as a nurse crop. A roller should be used in preparing the land, as clover frequently fails to germinate when sown on a very loose soil. A light dressing of manure thoroughly worked into the plowed land adds humus to the soil. If from animals fed on clover, it serves to inoculate the soil with the proper bacteria. This is especially necessary on land which has never grown clover and which is therefore probably not inoculated. Other means of inoculating the soil or seed is by spreading over the field a few wagon loads of surface soil from a good clover field or using the pure cultures distributed by this Department. In any case, care should be taken to see that weed seed is not applied to the land, as it is especially important to keep the land free of weeds where clover seed production is the principal purpose.

Although alsike and mammoth clover produce but one crop a year, they are sometimes clipped back during the first week in June for the sake of increasing the seed yield, but this is not the usual practice. Mammoth and medium red clovers, however, usually produce two crops, the second of which contains the seed. The first crop may be cut for hay before June 20, or when the clover is about 40 to 50 per cent in blossom, pastured until June 10, or clipped and allowed to remain on the land to maintain the soil fertility. Experiments at three points in Wisconsin indicate that late cutting produces an average yield of two-fifths of a bushel per acre more of seed than clipping, as well as 1½ tons of hay per acre. The poorer the soil or the drier the season, the earlier the clipping should take place or the grazing be stopped.

Clover should not be harvested for seed until the heads are nearly all ripe. Earlier cutting checks the growth of the seed, leaving it small and shriveled, while late cutting wastes much seed through breaking off or shattering the heads in handling. Cutting may be done with a mower with a bunching attachment, or that portion of the buncher which is tripped with the foot may be taken off and the sickle bar attachment, known as a "swather," left to turn the swath into a roll immediately behind the mower. The self-reaper is prob-

ably the more satisfactory machine, as it may be made to cut the clover as close to the ground as the mower in case it has gone down, or, if it stands well, the reaper may be made to cut it much higher, and thus save handling a large amount of straw. If carefully driven the reaper drops the bunches with the heads properly turned up to the sun and wind and in convenient shape for hauling to the huller in tight-bottomed racks six or eight days after it is cut.

Light showers on these bunches as they lie in the field are said to make the hulling easier, although heavier rains necessitate turning the bunches to facilitate drying. If not hulled immediately, the clover should be carefully stored on a tight floor, which will prevent the loss of heads broken off in handling, or carefully stacked and covered with boards, canvas, or marsh hay, which will shed the water in good shape.

Estimating the value of the hay at $10 per ton and seed at $6 per bushel, a return of $50 per acre is sometimes secured in addition to the straw left after hulling, which is a valuable feed. The return secured, whether large or small, need not be at the expense of the fertility of the land. The effect of growing clover seed in connection with live stock production is well illustrated by the experience on farms in three counties of the Willamette Valley. On a Benton County farm, winter wheat in which red clover was sown in February or March yielded 7 bushels of wheat in 1905, while the clover made a good stand and in 1906 yielded 5 bushels of seed per acre, but in 1907 was clipped too late and yielded only 1 bushel per acre, but in 1908 yielded 70 bushels of oats per acre. A 60-acre field in Yamhill County, Oreg., produced in 1901 18 bushels of wheat per acre; in 1902, 1903, and 1904, 7, 6, and 4 bushels, respectively, of clover seed; in 1905, 80 bushels of oats; in 1906, 30 bushels of wheat; in 1907, 4 bushels of clover seed. A 40-acre field in the same county produced, in 1903, 17 bushels of wheat; in 1904 and 1905, 6 and 6½ bushels of clover seed, respectively; in 1906, 65 bushels of oats; and in 1907, 27 bushels of wheat per acre. In Linn County, a 14-acre field of "mixed land," seeded to clover alone in June, 1906, pastured in late summer and fall, produced 5½ bushels of seed in 1907 and 38 bushels of oats in 1908, although a similar field of oats just across the fence made only 25 bushels per acre. The owner of this crop reports that the land is much more mellow and light than when plowed after the first seeding. It is safe to say that the nitrogen added by clover crops, together with the physical effects upon the soil of the roots and the droppings from the animals pastured upon the clover, have left these three fields in a much better condition than they were at the beginning of the rotation.

SUPPLEMENTARY HOME-GROWN FEEDS FOR HOGS IN THE SOUTH.[a]

P. N. Flint, of the Georgia Experiment Station, maintains that in view of the increasing price of commercial feeds more home-grown feeds must be used in order "to make money in growing swine." He insists that more attention should be given in the South to the growing of the more concentrated feeds like soy beans, Spanish peanuts, cowpeas, and corn as hog feed, and he reports experiments which show "that pork can be produced more cheaply when soy beans, Spanish peanuts, and skim milk are made a part of the ration, than when corn and shorts alone are fed."

One lot of pigs of an average weight of about 77 pounds was fed at the beginning of the experiment "3.3 pounds of corn and shorts—equal parts by weight—per pig. The ration was gradually increased until toward the end of the experiment they were consuming 5.3 pounds per pig of corn only. No shorts were fed during the last forty-eight days.

"In the case of [a second lot], at the beginning of the experiment, one-half as much corn as of skim milk was fed, namely, 2.3 pounds corn and 4.6 pounds skim milk per pig daily. As the experiment progressed, the proportion of skim milk to corn was gradually made smaller, and during the latter part of the experiment 5 pounds corn and 6.7 pounds skim milk per pig were fed."

Two other lots were fed the same quantity of corn, but one consumed 1 acre of soy beans and the other 1 acre of Spanish peanuts. Early and late varieties of soy beans were planted, one-fourth acre to the early variety and three-fourths acre to the late variety. When feeding of the early variety was begun, July 12, the beans were well developed, but far removed from being ripe.

"The early variety of the beans showed smaller stalks and fewer leaves than the late variety. The early variety was ripe a week previous to the time it was consumed."

When feeding of the late variety was begun, August 1, the pods had just made their appearance, so that during that time the pigs consumed largely leaves and stalks.

By September 1, the beans of this variety were in the dough stage and were ripe two weeks previous to the close of the experiment, September 29. During the period the pigs were consuming largely leaves and stalks, a larger quantity of corn was fed than during the last four weeks of the experiment, when there was a plentiful supply of matured beans in the pods. In fact, during the last two weeks, the pigs were fed but 1 pound per head of corn daily, but were given all of the beans they would clean up. This was done in order to dispose of the beans before ripening and casting their seed. Owing to the dry weather during the latter part of the summer, the beans did not bear a full crop.

[a] Compiled from Georgia Sta. Bul. 87.

When feeding of the peanuts was begun, July 12, they were not yet through blossoming, but many pods had formed and contained well-developed seed.

As with the soy beans, a greater quantity of corn was fed during the early part of the experiment while the peanuts were developing than during the latter part after the peanuts had matured. By the middle of August, the pigs, both in the peaut and the soy bean lot, were consuming 3 pounds of corn per pig daily and a light ration of soy beans and peanuts, while by the middle of September they were consuming but 1 pound of corn, and a heavy ration of soy beans and peanuts. The peanuts were well matured by the first of September. The drought did not injure the peanuts as much as it did the soy beans, hence in this experiment the peanuts had the better showing.

Both the peanuts and the soy beans were hauled to the pigs daily, as it was not feasible to fence the areas for pastures. Under ordinary conditions, it would be better to allow the pigs to gather the feed themselves, thus saving the expense of cutting, or pulling and hauling.

Except during the first thirty-one days of the experiment, the corn for all the lots was soaked in water from one feeding to another.

A mixture of charcoal, wood ashes, lime, salt, and copperas was constantly kept before each lot. They had access to hydrant water continually. They were kept in dry lots 20 feet by 64 feet.

Professor Flint discusses the relative merits of the different supplementary feeds and the practical methods of using them as follows:

Soy beans.—The soy bean makes a very good feed to combine with corn because it is rich in protein, in which corn is deficient. It is especially good for growing and breeding swine. Hogs will eat practically the whole plant when it is young and tender. The stems are not eaten so well after they become coarse.

There are several varieties of soy beans, and by selecting early, medium, and late varieties, or by planting the early or medium varieties a couple of weeks apart throughout the season, one planting will be sufficiently matured by the time the other is consumed. The hogs should be turned into the pasture when the first pods begin to ripen. Usually the soy bean has a more upright growth than the cowpea. It is richer in protein and, in some respects, a heavier yielder, which makes it more valuable as a hog feed.

The soy bean should be planted in rows about 30 inches apart, and at the rate of 3 pecks per acre. If the land is poor, 200 to 300 pounds of acid phosphate and 25 pounds of muriate of potash, in addition to stable manure, should be applied. Lime is also beneficial.

Spanish peanuts.—Spanish peanuts do best on sandy, loamy soil, but may be grown under a wide range of conditions. The land must be well limed, since they do not thrive well on land that is sour.

Spanish peanuts will mature in about ninety days, and as they will remain in the ground a long time they will have a long grazing period.

Stable manure produces abnormal tops and should not be applied in very great amounts unless it be the previous year to some other crop. Ordinarily, 200 pounds of acid phosphate, 100 pounds of kainit, and 1,000 pounds of air-slaked lime per acre will give good results.

They should not be planted until the land has become thoroughly warm. It is best to plant them in rows about 30 inches apart and 7 to 9 inches in the drill; the seed should be sown about 2 inches deep. At the last cultivation, the

soil should be thrown toward the rows. They should not be cultivated after the pods begin to form.

It is possible to plant a sufficiently early variety of soy beans that will come on before the peanuts are ready for feeding.

By growing soy beans, peanuts, and corn with which to fatten the hogs in late summer, and by providing rye, oats, and vetch, or alfalfa pasture during the winter and spring for the brood sows and young pigs, one will have the food problem admirably in hand.

Skim milk.—Skim milk, combined with shorts or corn, can not be excelled for growing pigs and mature breeding stock. Combined with corn, for fattening hogs, excellent gains in weight are made, being greater than is possible with corn only.

A circular of this Department dealing with hog raising in the South,[a] calls attention to the fact that feeding hogs on corn alone is unprofitable with present prices of corn. It is stated that—

The cost of raising hogs when fed on corn alone is generally estimated at 5 cents a pound, live weight, when corn is worth 50 cents a bushel, and 7 cents a pound when corn is worth 70 cents a bushel; that is, a bushel of corn will usually make 10 pounds of gain, live weight, when carefully fed to thrifty hogs. This agrees with the results at experiment stations. But corn is not usually fed with care, and when raised on corn alone hogs are seldom very thrifty; consequently the cost will average much greater than this. Investigations show that 7 pounds of gain to the bushel of corn is nearer the result when corn is fed on the cob without other food. This would place the cost of live gain at 10 cents a pound with 70-cent corn.

The best way to make hog raising profitable in the South is to graze the hogs upon pastures prepared especially for them, supplementing the green food by the addition of a small grain ration. Upon this plan hogs can be raised at an average cost of 1½ to 3 cents a pound, depending mainly upon the management of the sows and pigs and upon an economic plan of fattening.

A cropping plan to supply a succession of green crops is described in the circular.

FLESHING HORSES FOR MARKET.[b]

In a bulletin of the Illinois Station R. C. Obrecht states that "the fleshing of horses for market is a subject that has received but little consideration from investigators although the business is one of considerable magnitude and importance throughout the Middle West." He names among the factors which determine the profits or losses of the business: "The market class and grade of horses selected; the initial cost of the horses; their soundness; the cost of feeds; the efficiency of the ration for producing gains; the methods employed in feeding; the length of time necessary to feed to secure the desired finish; the retaining of health and soundness of the horses during the feeding period, and the season when marketed."

In view of the fact that most practical feeders follow the plan of using the feeds they can buy locally and then resorting to condiments,

[a] U. S. Dept. Agr., Office Sec. Circ. 30.
[b] Compiled from Illinois Sta. Bul. 141.

such as stock foods, "black strap" molasses, a cheap grade of brown New Orleans sugar, etc., for keeping up the appetite of their horses, their opinion as to the efficiency and economy of the feeds and appetizers used being most generally based simply upon personal observations, it was thought desirable to determine the relative value for this purpose of some of the common feeding stuffs. Experiments were therefore undertaken "to compare different rations for fleshing horses for market, in which corn, oats, bran, oil meal, clover hay, and timothy hay were used; and also, to determine the influence of exercise in taking on of flesh together with methods of stabling."

Two experiments were made, one with three lots of 6 horses each and lasting for 84 days (February 6 to May 1), the other with four lots of 6 horses each lasting for 112 days (October 24 to February 13).

[The horses] were classed as eastern chunks, with two exceptions, these being a little smaller and lighter boned than the others, were classed as farm chunks. They ranged in age from 4 to 7 years, were sound, of good color (7 grays, 7 bays, 3 browns, and 1 black), and apparently in good health when they arrived at the university farm. Judging from appearances, they had a greater percentage of Percheron blood than that of any other breed, although there were evidences of Shire blood in some of them.

The experiments showed that a mixed grain ration of corn and oats, when fed with clover hay, was more efficient than a single-grain ration of corn for producing large gains in an eighty-four-day feeding period. While the ration of corn, oats, and clover hay was more expensive with prices of feeds as stated than one of corn and clover hay, the gains are such as to make its use more economical.

Clover hay was 58 per cent more efficient for producing gains than timothy hay.

A ration of corn, oats, and timothy proved satisfactory for producing finish in fleshing horses for market, but was materially improved by the addition of oil meal.

A ration of one-fourth oats and three-fourths corn proved more economical than one of half oats and half corn.

A ration of corn and bran fed in proportions of one part bran to four parts corn by weight was superior to an all-corn ration for producing gains when fed in conjunction with clover hay.

There is apparently danger of feeding too much bran for best results when clover hay furnishes the roughage part of the ration. The bran and clover combined produced a too laxative condition.

In these tests the narrower the nutritive ratio the larger were the gains; the best results were secured with a nutritive ratio of 1:8.

Exercise had a retarding effect upon the taking on of flesh, the horses receiving no exercise making 24 per cent more gains than those having a daily walk of 2.8 miles.

It is stated that while box stalls are safer than single stalls for stabling horses, they are also more expensive and, as far as these experiments show, do not offer merits not possessed by single stalls with regard to the taking on of flesh. The horses stabled in single stalls made 16 pounds, or 8 per cent, more gains in eighty-four days than those in box stalls.

Professor Obrecht is of the opinion that thin horses of some market classes will not return as large a profit in feeding as those of other classes. He states that the kind of horses it will pay best to feed depends partially upon the season of the year when marketed. All heavy horses will pay better than light horses, and good and choice animals better than those of the lower grades.

FERTILITY AND HATCHING OF EGGS.[a]

It is well known that hens vary widely in the number of fertile and hatchable eggs produced. The Maine Station has been studying for several years the causes of this variation and the relation between fertility and hatching quality. In a recent bulletin of that station, Raymond Pearl and Frank M. Surface state, as a result of these studies, that while "fertility and hatching quality or ability of eggs are two essentially different things," there is apparently a small but still sensible correlation between the two.

This means that in general or on the average the hen whose eggs run high in fertility will also tend to show a high hatching quality of eggs (percentage of fertile eggs hatched) and vice versa.

Conditions of housing have a marked and definite influence on the mean or average fertility and hatching quality of eggs. In the experiments here discussed it was found that both fertility and hatching quality of eggs were very much better when the breeding was done in a "curtain-front" house, which furnished an abundance of fresh, pure air, than when it was done in what was formerly considered to be a highly desirable type of heated house, without curtain-front but with a supposedly adequate system of indirect ventilation. * * *

While there are great individual differences among different females in respect to the fertility of their eggs, even when mated to the same male, it still remains the fact that this character, as compared with hatching quality of eggs, is to a very large degree influenced by external circumstances. * * * The same relative degree of fertility is not characteristic of the same bird in two successive seasons; nor is this character affected by winter egg production. It is not inherited.

On the other hand, the hatching quality of eggs is an innate constitutional character just as much intrinsic as any other physical character, such as shape of body or length of limb. Relatively the same intensity or degree of this character is persistent in the same bird in successive breeding seasons. It is adversely affected by heavy winter egg production. It is inherited. * * *

Any factor which tends to reduce or impair the general constitutional vigor of breeding birds in general tends also to reduce the hatching quality of the

[a] Compiled from Maine Sta. Bul. 168.

eggs from these birds. The relative "condition" or vigor of breeding birds may be impaired in a variety of ways. For example, improper feeding may bring about this result. * * * High winter egg production has, on the average, an adverse effect on the hatching quality of the eggs produced by the same birds in the subsequent hatching season. This again can probably be regarded as the result of a reduction of constitutional vigor following heavy laying. * * * Similarly adverse housing conditions most probably produce the bad effect which they have been shown * * * to have upon hatching quality by lowering the general vital condition of the fowls.

To this factor of constitutional vigor as affecting hatching quality of eggs the experiments of the Maine Station add another, viz, inheritance:

Hatching quality of eggs is in some measure a "bred in the bone" character of poultry, and must be reckoned with as such. * * * But if hatching quality is inherited it means that it is a character which can be improved by selective breeding. * * *

[This emphasizes] the importance in practical breeding work of (a) the selection of breeding stock with reference to constitutional vigor or vitality, (b) the maintenance of the breeding birds in a vigorous condition by proper methods of housing and feeding, and (c) paying attention to the actual breeding ability (as shown by hatching performance) of the stock and the exercise of selective breeding to improve this character.

THE MARKETING OF EGGS.[a]

From a discussion of this subject by A. G. Phillips in a bulletin of the Kansas Station the following facts are drawn:

The demand for eggs seems practically unlimited, more especially for the better grades. The growth of the storage industry has tended to equalize prices by increasing the demand in summer when fresh eggs are plentiful and supplying the deficiency in winter when fresh eggs are scarce. Since the demand is greatest for the best grades, it seems obvious that a little more attention to details will result in a profit amply repaying the extra time and labor involved.

It is not the purpose here to enter into any discussion of the ways of increasing the production of eggs, but simply to point out the possibilities of profit as a result of extra care in handling and marketing the eggs now produced; the extra profit is to be made by obtaining the top retail price, and, as consumers become acquainted with the product, by obtaining a premium of from 1 to 5 cents per dozen over the regular price paid for ordinary eggs.

In order to obtain top prices for eggs, they must be uniform in size, uniform in color, and uniform in quality. The uniformity in color is not always important and depends on the market; uniformity in size excludes small eggs and unusually large ones as well; while uniformity in quality calls for absolutely clean eggs that have been gathered promptly after being laid, kept under the best possible

[a] Compiled from Kansas Sta. Bul. 162.

conditions, and marketed not more than three or four days after they are laid. It should also be noted that only eggs with firm strong shells should be marketed. One thin shelled egg may not only prove a total loss but may also soil half a dozen others.

In order that eggs may be clean, it is necessary to provide clean nests for the hens to lay in. The eggs should be gathered at least once a day and oftener in warm weather. The eggs should be kept in a clean, dry, cool place. Any small or dirty eggs should be used at home; a dirty egg if used at once is as good as any, but it will not keep as well and will spoil the sale of clean eggs. Never put in an egg that is not known to be absolutely fresh.

The time of marketing will depend on local conditions, but should be as often as once a week at any time of the year and at least twice or three times a week in summer. In cases where it is impossible for a farmer to take his eggs himself as often as that, he can arrange with a neighbor to take the eggs on alternate marketing days.

The methods of selling the eggs will depend on the distance from the market, the number of eggs to be disposed of, and other conditions that will vary in different places. Where it can be done in connection with the sale of other produce, such as dairy products, the most profit can usually be made by selling direct to the consumer. In such case it will probably pay to put the eggs either in plain cartons or in cartons which have the name of the farm printed on them. The plain cartons can be bought for 60 cents a hundred, or perhaps for less in large quantities; when printed, of course, the cost would be greater, but it would probably not exceed 1 cent each.

If it is not feasible to sell the eggs direct to private customers, it may be possible to sell them to a grocer who has a high-class trade and will be glad to get absolutely reliable eggs for his customers. In such a case it would be worth while to put the eggs up in cartons, with the name of the farm on them, in order to educate the customers to call for eggs from that farm. When a farmer has a good many eggs and does not wish to bother with cartons, he can often do well by selling his eggs to a hotel or restaurant.

If none of the ways suggested are feasible, then the eggs can be sold to dealers, but an extra price can be obtained from them also as soon as they are convinced that the eggs furnished them are absolutely reliable.

If there are children on the farm, they can be taught to care for the eggs, and will take pride in doing it well, especially if they are given a share in the profits.

It should be remembered that it will take time to work up a demand for selected eggs, but when people are once convinced that the eggs can be depended on, they will not only call for such eggs, but will tell their friends about them.

CEMENT SILOS.[a]

In a recent bulletin of this series[b] attention was called to certain faults of construction which extended experience in the use of silos had revealed, and suggestions were made as to how these faults might be corrected. Some reference was there made to the use of cement for silo construction. The use of cement for this purpose is more recent than that of wood, brick, stone, and metal, but is becoming very general and has already been sufficiently tested by practical experience to indicate its merits as compared with other structural materials, as well as the methods of construction most likely to give satisfactory results.

Three types of cement silos are commonly constructed—single-walled, double-walled, and concrete block. The single-walled and concrete block types are perhaps the more popular at the present time because more simply and easily constructed. However, very satisfactory results have been obtained with all three types when properly constructed.

In a recent bulletin of the Michigan Experiment Station, J. A. Jeffery reports that there are many cement silos in that State which have proven durable and efficient and he describes in detail seven such silos. He states that—

At the present time the cement-block silo is more popular than the solid-wall cement silo. Two reasons may be assigned for this fact:

(1) The expense and labor entailed in building forms for a solid cement wall are considerably greater than in building a form for making cement blocks. When forms are built for a single solid-wall cement silo this difference in expense is magnified. This observation does not hold where the professional silo builder is employed.

(2) The work of constructing the cement-block silo seems to be more attractive than that of constructing the solid wall silo.

He believes that it will generally be found "that in the homemade silo the block wall is better and more symmetrically constructed than is the solid wall."

Professor Jeffrey describes a solid-wall cement silo in successful use in Michigan as follows:

This silo has an inside diameter of 14 feet and a total height of wall above floor of 30 feet, including 6 feet of cobblestone-cement foundation. The floor stands 5 feet below ground. The foundation wall is 12 inches thick and extends 6 inches below the floor. The lower 12 feet of the cement wall is 10 inches thick. The upper 12 feet is 8 inches thick. * * *

The doors of the silo, four in number, are 24 inches by 36 inches. They are especially well made of two thicknesses of lumber, with beveled edges, refrigerator style, and fit snugly into equally well-made frames, which in turn are built into the walls. The doors are set into the frames from the inside and are held in place by the silage.

---

[a] Compiled from Michigan State Bul. 255.

[b] U. S. Dept. Agr., Farmers' Bul. 353, p. 22.

After the construction of the walls they received an application outside and inside of a rich cement wash. The inner face of the foundation received a half coat of rich cement plaster.

In the construction of this silo there were used:

30 barrels cement.
35 cubic yards sand.
1½ cords stone.
1 bale barbed fence wire for reinforcing the walls.

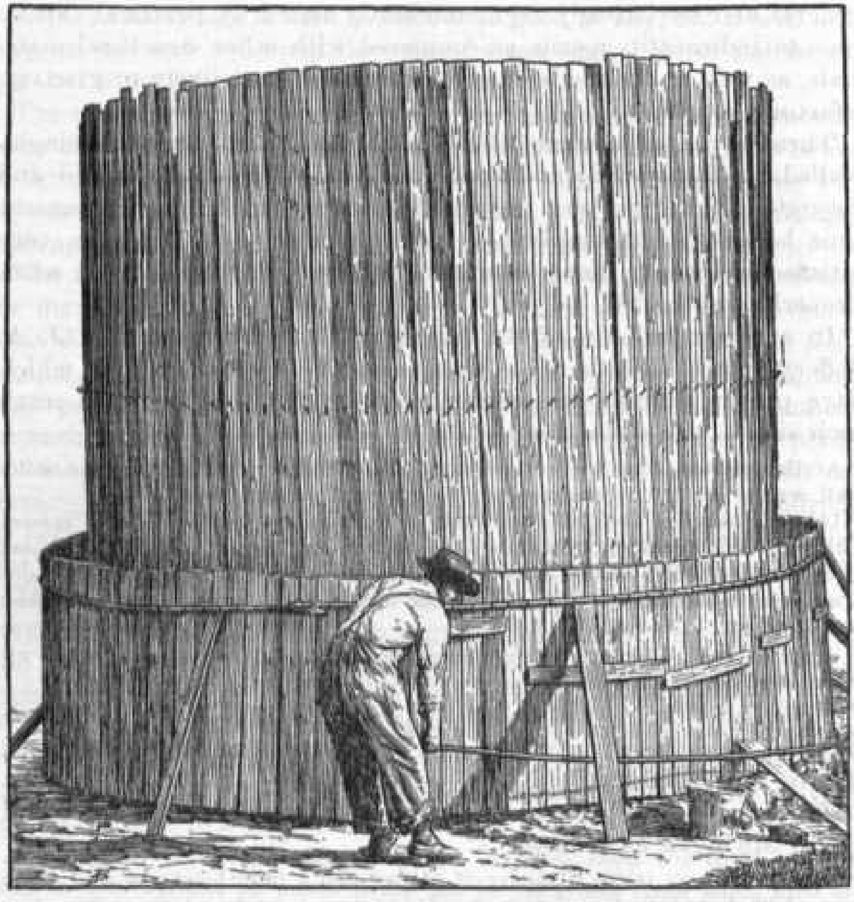

FIG. 1.—Setting up the forms for the construction of a single-walled silo.

For forms there were used:

1,100 feet lumber ⅞ inch by 4 inches by 16 feet.
4 hoops half-round iron with lugs.
30 pounds nails.

A total of thirty-one days of labor was expended upon the construction. It would require considerably less labor for the same parties to build another silo of the same size after having acquired more experience.

Figure 1 gives a fair idea of the kind of forms used and the manner of using them. The inner form was 16 feet high and had to be moved but once. The

outer form was 4 feet high and was lifted nearly 4 feet each time it was moved. It was clamped to place by means of the hoops and lugs mentioned above.

Two strands of barbed wire were built into the concrete every 18 inches in the lower wall, as the forms were filled, and less frequently as the building of the wall progressed.

The proportion of cement and gravelly sand in the concrete of the wall is 1 to 7.

A solid-walled cement silo was built at Michigan Agricultural College in 1905.

It has an inside diameter of 15 feet and a height of 31 feet, standing about 5 feet in the ground and about 26 feet above ground. When well filled, it holds about 90 tons of ensilage. * * *

The wall is 10 inches thick from the ground to plate.

The openings for the doors are 24 inches wide and 36 inches high and are 2 feet apart. Only the top opening carries a frame. Each of the other openings carries a shoulder sufficiently deep, molded into the inner side of the wall, to carry a door of 1-inch material flush with the inside wall. This door, made of inch material (flooring in this case), held together by cleats, is set in place in the doorway, and against the inner side is placed, in the same manner as in the other silos, a piece of galvanized sheet iron sufficiently large to lap 2 inches beyond the doors, thus preventing the passage of air through and about the door.

In building that part of the wall below ground a circular trench 14 inches wide and with an inside diameter of 15 feet was dug, 6 feet deep. The digging of such a trench was made possible by the fact that the ground here was all clay. This trench was used as a form into which to build the below-ground wall with the exception indicated below. After the completion of the upper wall the earth inside was excavated to the depth of the wall, 6 feet, and a cement floor was laid.

In building the wall above ground an inner and an outer form were used, each 4 feet high. The inner form was made in two sections of 2 by 6 hemlock nailed to wooden half circles. One piece of 2 by 6 was loose, to be removed to loosen the form before lifting and to bring it back close to the inner surface after lifting.

The outer form was made of 4-inch hemlock strips held together, in part, by a 28-inch strip of sheet iron covering a little more than the upper half of the inside, and in part by two iron hoops with turn-buckles. The hoops with turn-buckles performed the further office of drawing the outer form tightly against the outer surface of the wall after each lifting of the form.

The outer form was set 2 feet down into the trench and properly adjusted to build the upper 2 feet of the below-ground part of the wall. The inner form was then properly set in place and the upper 2 feet of the below-ground wall and the first 2 feet of the above-ground wall was set up. From this point until the wall was completed the outer form was raised about 24 inches each time, while the inner form was raised at the rate of about 48 inches, i. e., its full width. By raising the outer form at the rate of 24 inches each time each section of wall was set up against sheet iron, which insured a smoother wall than could be had if set up against wood.

Wooden forms were used to shape the openings for the doors.

To reenforce the walls, pieces of No. 9 fence wire were built into the concrete at intervals of about 1 foot.

In sections of the wall between doors these pieces of wire extended completely around the silo and were so built into the concrete.

In those sections which were to contain doors a 4-foot piece of ¾-inch gas pipe was set up about 6 inches out from where the door should be, one on each side, and so that one end of each piece stood 6 inches above and one end of each 6 inches

below where the door should be. The ends of the pipes extending above the door were then tied together with a few twists of wire, as were also those extending below. To these pieces of pipe were tied the ends of the pieces of wire which were to be built into the walls of the section, and so were built into place.

The concrete used in the construction of the wall was made of mixed sand and gravel and a good Portland cement. The wall is of the same thickness from ground to plate, 10 inches, but the richness of the concrete varies. The proportion of sand and gravel to cement in the first 13 feet above ground is 6 to 1. In the upper 13 feet the proportion is 7 to 1.

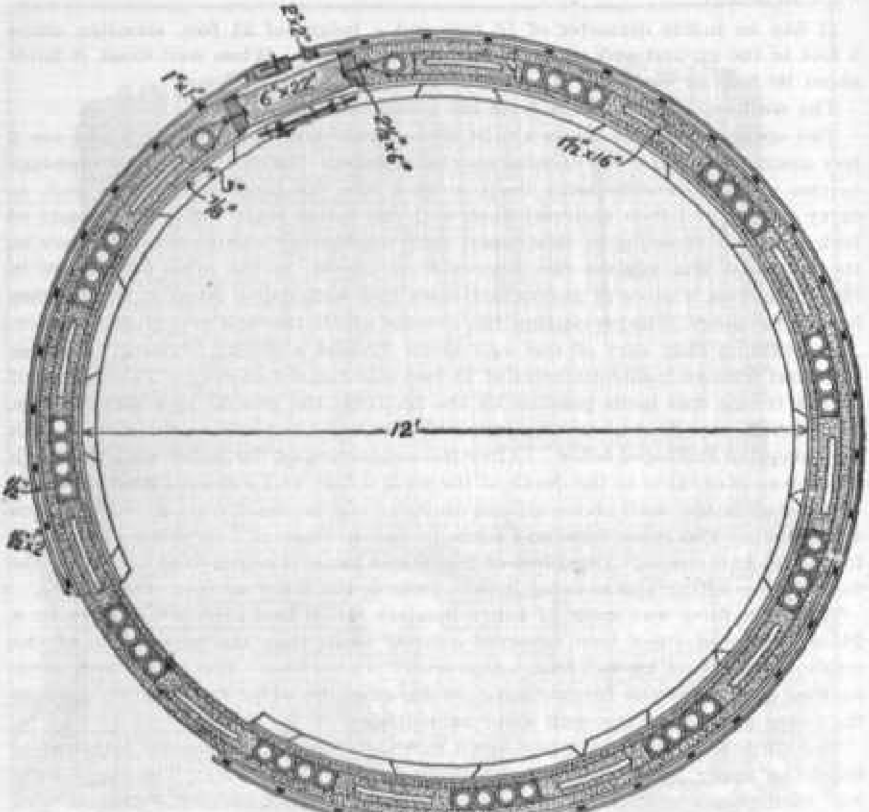

FIG. 2.—Cross section of wall and forms of double-walled silo.

After completion both the inner and outer surfaces of the wall were "whitewashed" with a rich cement wash.

The wall is surmounted by a plate made up of four thicknesses of ⅞-inch hemlock boards, sawed to the circle of the wall and held in place by bolts built into the wall.

A successful homemade hollow-walled cement silo is thus described:

It has an inside diameter of 12 feet and stands 36 feet high above the floor. The floor stands 4½ feet below the surface of the ground and 6 inches above the bottom of the foundation.

The lower 3 feet of the foundation is of cobblestone and cement. The upper 2 feet is of concrete. The foundation is 10½ inches wide at the top and broadens

inward and outward to about 17 inches at the base, the floor having a diameter of only 11 feet. The silo wall above ground has a uniform thickness of 8 inches and is unique in its construction. Forms are used in its construction, but the wall is rendered "hollow;" first, by the use of forms, and, second, by the building into the wall of tiers of No. 2 3-inch drain tiles. Figure 2 represents a horizontal cross section of the wall. It shows not only the arrangement of the tile and other hollow spaces but also the outer and inner forms, the plan of the door frame, and the manner of reenforcing the walls with the wire cables. The hollow spaces formed by the tile and by the forms are continuous. The tiles begin 6 feet above the foundation, form spaces lying below the tile. The form spaces are continuous from foundation to top of wall.

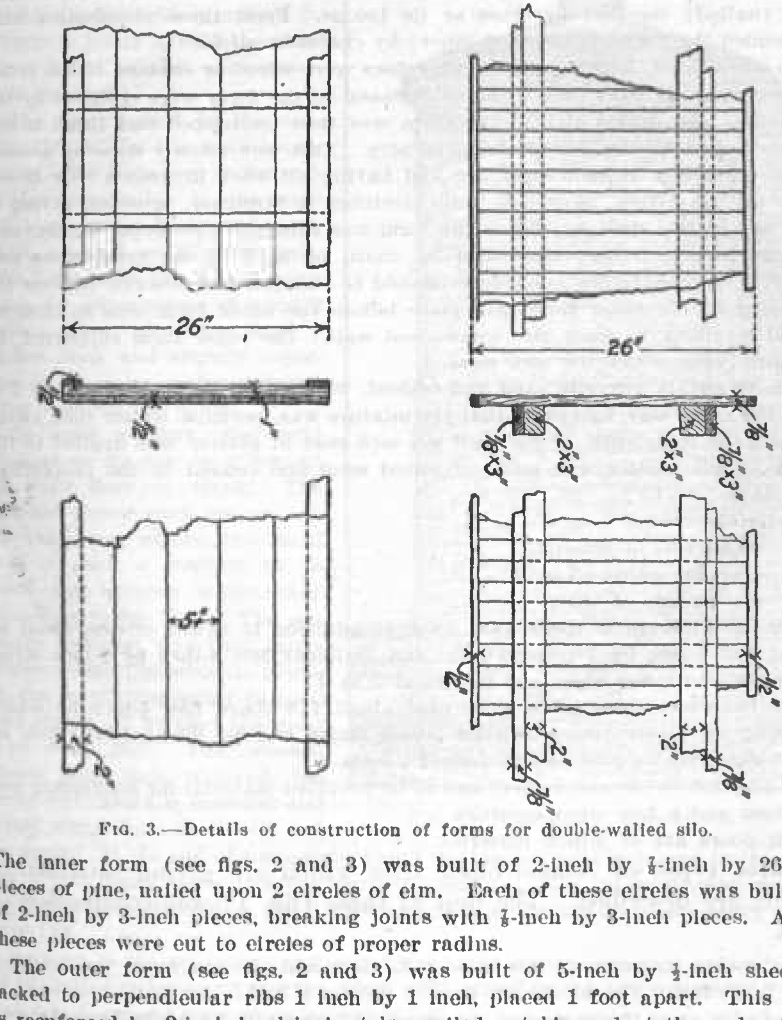

FIG. 3.—Details of construction of forms for double-walled silo.

The inner form (see figs. 2 and 3) was built of 2-inch by $\frac{7}{8}$-inch by 26-inch pieces of pine, nailed upon 2 circles of elm. Each of these circles was built up of 2-inch by 3-inch pieces, breaking joints with $\frac{7}{8}$-inch by 3-inch pieces. All of these pieces were cut to circles of proper radius.

The outer form (see figs. 2 and 3) was built of 5-inch by $\frac{1}{2}$-inch sheeting tacked to perpendicular ribs 1 inch by 1 inch, placed 1 foot apart. This form is reenforced by 2-inch by $\frac{1}{2}$-inch strips nailed outside and at the ends of the ribs. These forms were clamped into place by means of two $\frac{1}{2}$-inch bolts in each form as shown in figure 2.

The frame for a continuous doorway (fig. 2) is made of $2\frac{1}{2}$-inch by 6-inch oak bridge timber with a 1-inch by $1\frac{1}{2}$-inch strip on the inner edge against the

cement, which strip acts also as a shoulder for the doors. An inch strip on the outside of the 6-inch piece makes the thickness of the door frame equal to the thickness of the wall. Crosspieces of the same 2½-inch material are set in the frame 3 feet apart, center to center. The inside width of the frame is 22 inches. The frame thus constructed was set up so that the sill stood 1 foot above the foundation, properly braced, and so was built into place.

For reenforcement, wire cables were built into the wall at intervals of 18 inches. The manner of stretching the cables is shown in figure 2. In the lower wall, four No. 7 wires were twisted together for this purpose; in the upper wall, two No. 7 or No. 9 wires were twisted together.

Four posts were set up at quarters about the silo. The opposite posts were tied (nailed) together by cross or tie beams. From these crossbeams were suspended the forms (outer and inner) by chains or wires.

To lift a form, four wire-fence stretchers were wired or chained to the crossbeams, one near each post. Chains fastened to the form were clutched by the stretchers and drawn tight. The form was then unclamped and lifted to the proper height by the use of the stretchers. This was usually done by placing a man or a boy at each stretcher and having all work in unison. Or if one man did the lifting, he passed from stretcher to stretcher, in order, giving to each one or two strokes. When the form was raised to the proper height, usually 24 inches, it was suspended by chain or wire to the crossbeams and properly clamped. The outer form should be clamped first always, because the clamping of the inner form into place before the outer form was so clamped would be likely to crack the unseasoned wall. The inner form supported the platform upon which the men worked.

The materials, gravelly sand and cement, were mixed in the proportions 5 to 1, in the usual way, excepting that the mixture was, perhaps, wetter than usual.

Upon the completion of the wall a ¼-inch coat of plaster was applied to the inside. This plaster was made of sifted sand and cement in the proportions of 2 to 1. * * *

Materials used:

- 40 barrels of cement.
- 40 cubic yards of sand.
- 400 pounds of wire.

For the inner form there were used, in addition to sawed circles, about 95 board feet ⅞-inch by 2-inch material and 75 linear feet ½-inch by ⅜-inch strips for upper and lower edges and 2½ feet of 2 by 4.

For the outer form there were used about 115 board feet ½-inch by 6-inch sheeting, 80 linear feet ½-inch by 2-inch strips and 84 linear feet 1-inch by 1-inch material for ribs and 2½ feet of 2 by 4.

In addition to the above there had to be provided material for scaffolding and platform and a few other sundries.

The doors are of 1-inch material.

Three types of cement-block silos which are giving satisfactory results are described. The first of these (fig. 4) was constructed in 1904.

The inside diameter of this silo is 16½ feet and the height of cement-block wall is 28 feet. The blocks all have a face of 9 inches by 36 inches, but not all have the same thickness and structure. There are thirty-eight tiers of blocks in the wall. The blocks of the lower twelve tiers are hollow and are 10 inches thick. Those of the next fourteen tiers are hollow and are 8 inches thick. Those of the upper twelve tiers are solid and have a thickness of 6 inches. Gravelly sand and cement in the proportion of 5 to 1 were used in the construc-

tion of the blocks, and it is estimated that one barrel of cement will make sixteen 8-inch blocks. Seven hundred blocks were required. The blocks were laid in a rich cement mortar of 2 parts sand to 1 of cement.

There are three doorways, each three tiers deep and one block (36 inches) wide. Two-inch shoulders were molded into the blocks bounding the doorways at the time of making the blocks and these shoulders carry doors made of double thickness flooring with building paper between. The lower doorway rests upon the sixth tier of blocks above the floor and each doorway is separated from next (above or below) by five tiers of blocks.

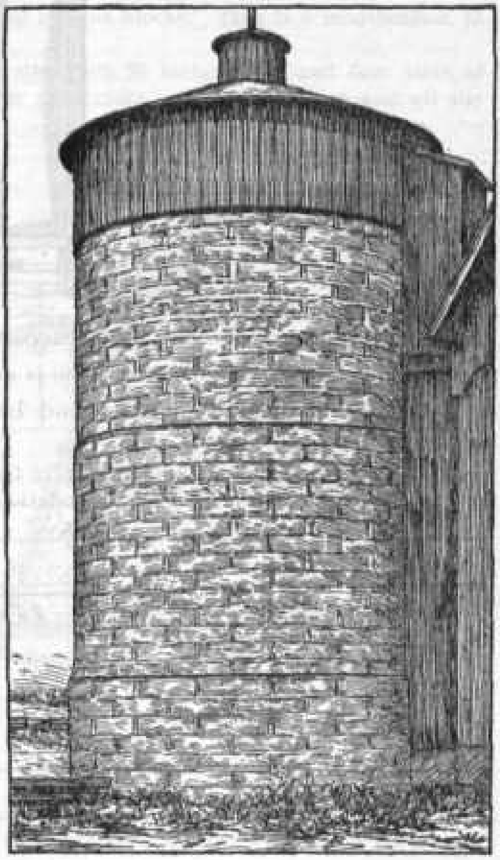

FIG. 4.—A successful cement-block silo.

In laying the upper tier of blocks, twelve bolts were set in alternate joints to hold the plate for a 4-foot wooden superstructure and roof.

The blocks used in the construction of the silo were homemade. The form seen in figure 5 is also homemade. It was made of wood with front and back faces covered with sheet iron. The hollows in the blocks were made by using pieces of wood 2 inches thick, 10 inches long, 9 inches deep, and slightly tapering so as to be easily removed after molding the block.

To mold a block, the mold was set on its side on a cement or other floor or plank. The wooden pieces were set on end on the floor within the mold and in such a position as to form the hollows where they should be in the block. The wet mixed material was then introduced about the wooden pieces in the mold, thoroughly tamped and struck off so that the mold was even full. The wooden pieces were then removed, the mold was carefully loosened and lifted away from the block and set again. At the end of forty-eight hours the blocks could be placed in the wall, but it was found better to allow them to stand ten days before placing in wall.

To reenforce the wall a No. 8 wire was laid in the mortar above every alternate tier.

As soon as the wall was constructed the inner surface received a ½-inch coat of plaster of rich cement mortar, sand, and cement in the proportions of 2 to 1. A 4-inch cement floor was also put in.

It is estimated that with the style of portable mold used in this work (fig. 5) three experienced men can make one hundred 10-inch by 32-inch by 8-inch blocks in ten hours.

This silo was three weeks in building and filling was begun two days after its completion. A few weeks, at least, should elapse after the completion of such a silo before it is filled. Filling the silo so soon, resulted in a crack over each doorway. Three old hoops belonging previously to a stave silo were put about the silo, as shown in figure 4, and the cracks pointed with a rich cement mortar, since which the silo has worked very satisfactorily.

A diversity of views is expressed as to the effectiveness of the hollow block in preventing the freezing of the ensilage. It is asserted that in this silo the ensilage was frozen 2 feet back from the solid 6-inch blocks of the upper wall, but that practically no freezing occurred back of the hollow blocks below.

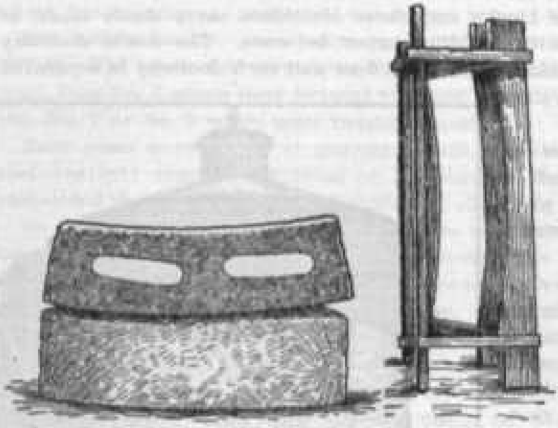

FIG. 5.—Cement blocks and form used in making them.

The quality of the ensilage in this silo is said to be very uniform throughout.

A second block silo planned and built by the owner is thus described:

[This silo] has an inside diameter of 12 feet and a height of 30 feet. In the construction of this silo a cement foundation 18 inches thick was laid extending down from the surface of the ground 4½ feet. The cement floor stands 6 inches above the base of the foundation. Upon this foundation the superstructure of thirty-five tiers of cement blocks is built. All but the upper five tiers of blocks are hollow and all have a face of 24 inches by 8½ inches. The blocks of the lower tier are 10 inches thick. Those of the second tier are 9¾ inches thick, and those of the third tier are 9½ inches thick, and so on up. The thickness of the blocks of any tier is ¼ inch less than those of the tier next below.

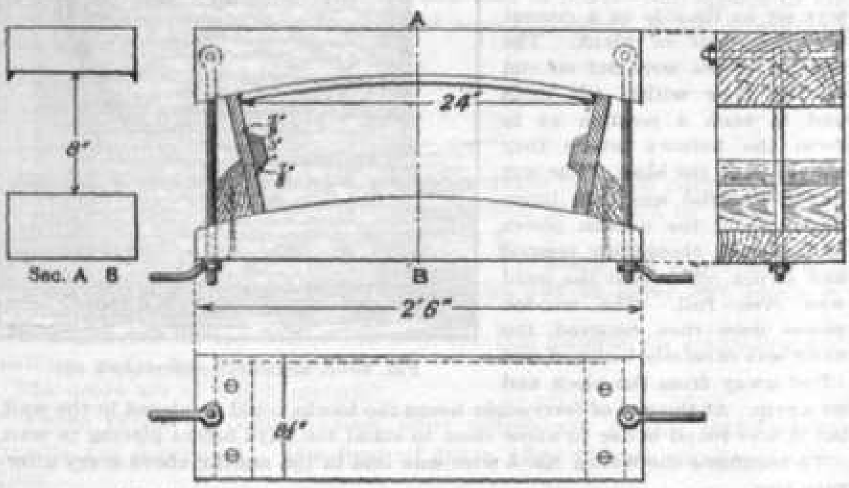

FIG. 6.—Plans and elevation of form for making cement blocks.

The form used in constructing the blocks was similar to that used to make the blocks for the [above] silo. As soon as a sufficient number of blocks was made for any tier the outer edge of the ends of the form were trimmed down ⅛ of an inch and then the blocks for the next tier were made, and so on. The hollows in the blocks vary from 4 inches by 7 inches in the 10-inch blocks to 2 inches by 7 inches in the 6½-inch blocks of the thirtieth tier.

In laying up the blocks the inner surface of the wall was kept perpendicular. When the wall was completed the inner surface received a ½-inch coat of rich cement plaster, screened sand and cement in the proportion of 3 to 1.

Figure 6 shows a form for making cement blocks. This is a modification of the form [referred to above].

There are four doorways to the silo, each 23 inches wide and four tiers of blocks high (36 inches). The lower door rests on the foundation and all the doors are separated from each other by four tiers of blocks. There are no door frames. The doors are very simply made of one thickness 6-inch common flooring, nailed to two cleats, and just fill the opening. They rest against no jambs. Nailed upon the inner surface of each door and overlapping ends and sides by 4 inches is a piece of galvanized sheet iron. Each door is set in place from the inside and is held from slipping outward by the sheet iron. The pressure of the ensilage material against the sheet iron seals the doorway. The question naturally arises concerning the strength of this sheet-iron lining used in this way. After two seasons' use there does not appear any evidence of insufficient strength in this arrangement of door.

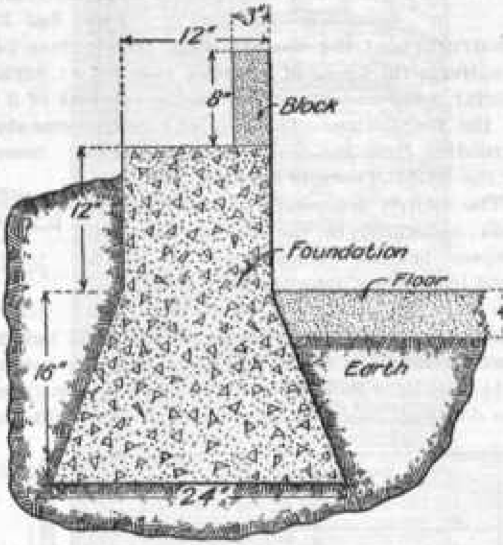

FIG. 7.—Section of foundation and floor of thin solid-block silo.

The walls were reenforced by imbedding two strands of barbed wire in the mortar underneath the first tier of blocks below each doorway and in the mortar over the tier of blocks above each doorway.

For the roof, eight 2 by 4 rafters were used and were given a 2-foot rise to the center. The rafters were covered with sheeting, leaving a scuttle door 2 feet by 3 feet and the sheeting was covered with a 3-inch layer of cement mortar. The rafters were set upon plates bolted to the top of the wall, the bolts being set in the cement. * * *

In constructing this silo, there were used:

31½ barrels of cement.
26 cubic yards sand.
700 feet barbed fence wire.

The lumber for doors and roof cost $5.

It is estimated that with the methods used a man can make 30 blocks per day. "Two men can lay up six tiers or courses of blocks per day. Eight hours were required for two men to build the roof."

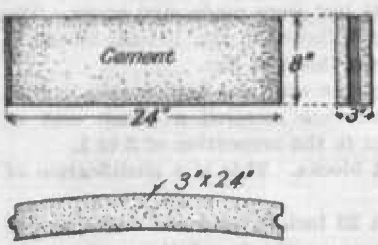

FIG. 8.—Thin solid cement block for silo construction.

A silo built of thin solid blocks is described as follows:

This silo has an inside diameter of 12 feet and is 28 feet high. The foundation stands 4 inches above ground and extends 24 inches below ground. The upper 12 inches of the foundation is 12 inches thick and the lower 16 inches widen symmetrically to 24 inches at the base (see fig. 7). The blocks used in the construction of the silo are solid, have a face 24 inches by 8 inches, and have a uniform thickness of 3 inches (see fig. 8). The blocks are laid up in cement mortar, sand and cement in the proportions of 2 to 1, flush with the inner edge of the foundation. There is one continuous doorway, about 25 inches wide, extending from the first course of blocks to the roof. There is no door frame.

FIG. 9.—Section of silo wall showing doorway, brace, and hoop.

The wall is not reenforced by wires or rods embedded in the mortar between courses but is strengthened by 2-inch band-iron hoops upon the outside such as are sometimes found on stave silos. The hoops are placed four courses, or about 33 inches, apart, and are drawn firmly against the walls by lugs. In the doorway behind each of these hoops is fitted a 1½-inch by 4-inch piece of wood to prevent yielding of the boundary wall of the doorway when the hoops are drawn tight. (See fig. 9.) These pieces act also as supports to which are nailed pieces of 2 by 4 for frames for chute, and for ladder for reaching the upper portions of the doorway.

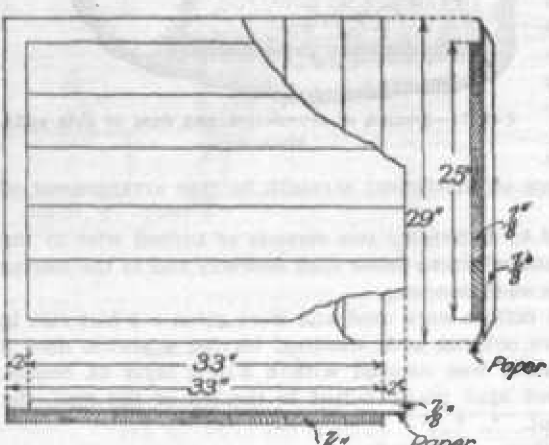

FIG. 10.—Door used in silo shown in figure 9.

The doors, made in sections, are formed of two thicknesses of flooring with two thicknesses of tar paper between. The inner thickness of flooring, which sets horizontal, laps 2 inches when in place, as does the paper, on either side of the doorway and rests against the inner surface of the wall. The sections are made to lap upon each other also. (See fig. 10.) These doors are held in place by the pressure of the silage. The ends of the inner layer of boards are beveled back to the wall.

When the silo was first built the inner surface of the wall was not plastered but was treated with an application of a preparation (probably water-glass)

which was recommended as having the property of closing the pores of the concrete and thus rendering it air-tight. It did not accomplish this result. That year as much as 6 or 8 inches of all the ensilage next to the wall spoiled completely. Before filling the silo again the inner surface of the wall received a ½-inch coat of rich cement plaster. When the plaster had set it was given a coat of rich cement wash. Since that time there has been no poor silage.

Proportions of materials used:

For the foundation, 1 part cement to 7 of gravelly sand.

For the blocks, 1 part cement to 5 of gravelly sand.

Floor, made wet, 1 part cement to 5 of gravelly sand.

Mortar for laying wall and plastering, 1 of cement to 2 of screened sand.

Wash, cement and water.

Roof:

The roof consists essentially of eight rafters set at low pitch, covered with sheeting (flooring in this case) and the sheeting in turn covered with rubberoid. A section of the roof is removable and through this doorway the ensiling material is introduced.

This silo was built by contract for $176 complete. It has been in use five years.

A cast-iron form was used in making the blocks. Such a form can now be purchased on the market and will cost something like $15.

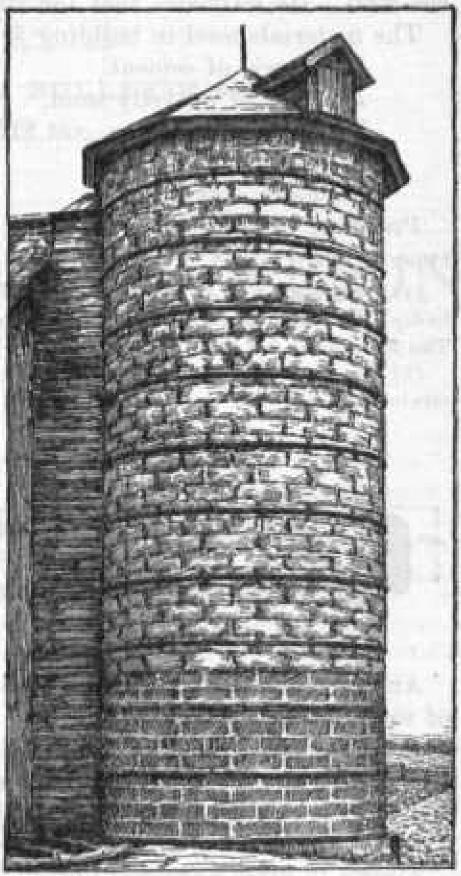

FIG. 11.—Silo built of thin cement blocks with iron hoops.

Another silo of this type (see fig. 11) is 12 feet inside diameter and is 34 feet high, extending 4 feet below ground.

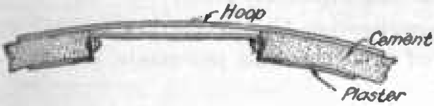

FIG. 12.—Section of silo wall showing doorway and brace and frame of steel and hoop.

The 24½-inch continuous doorway has a frame of 3-inch by 3-inch by 5/16 angle iron. (See fig. 12.) Braces of ¼ by 1½-inch iron are bolted to the opposite angles and at intervals of 33 inches fall under the hoops. This frame is set to receive in the angles of the frame the inner corners of the blocks bounding the doorway and gives to the doorway both strength and durability. The plaster applied on the completion of the wall is reduced in thickness, next the doorway, to that of the angle iron.

This silo is covered by a shingle roof. The blocks for the silo were made by the builder himself but he hired the labor to build them into the wall. He estimates that the silo complete cost him about $150.

The materials used in building foundation and walls were:

15 barrels of cement.
14 loads of gravelly sand.
The steel door frame, cost $12.
11 hoops, cost $18.
11 doors, cost $11.

Professor Jeffery states that two objections are heard against this type of silo:

(1) The walls are so thin (3½ inches complete) that the silage must freeze badly. To this the owners with whom we have talked say, "It is not true. The freezing is not more severe than in a stave silo."

(2) The walls are not thick enough to be sufficiently strong to endure the strain to which they are subjected.

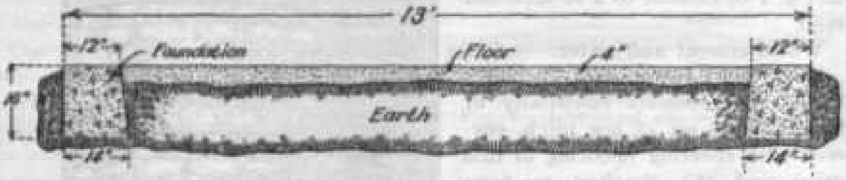

FIG. 13.—Section of silo foundation with floor at surface of ground.

An examination of 25 or more silos of this type showed no evidence of weakness or failure.

It is estimated that the solid wall and block silos of the same capacity require about the same amount of material. For the foundations of any of these silos there would be required: 3 barrels of cement, 3 cubic yards of sand and gravel.

Figure 13 gives a general idea of how such a foundation should be built. The doors and roofs should not differ materially for the same style.

Professor Jeffery calls attention to the fact that "the quality of the ensilage will depend in no small degree upon the care and thoroughness with which the materials are introduced into the silo at the time of filling," and especially emphasizes the necessity for careful packing. "Careful distribution of material and persistent tramping are necessary to proper success."

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to any Member of Congress or the Secretary of Agriculture.]

O